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A-91-46

A-91-46

IV-E-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Meetings with Ford Motor Company and Ethyl Corporation Regarding HiTEC 3000 Waiver Application

FROM: David J. Kortum, Environmental Engineer
Fuels Section

TO: Docket A-91-46 (LE-131)

The purpose of this memorandum is to transmit to the docket substantive information regarding an application by the Ethyl Corporation to use the fuel additive methylcyclopentadienyl manganese tricarbonyl, commercially known as HiTEC 3000, as an additive in unleaded gasoline. This memorandum summarizes one meeting held between Environmental Protection Agency (EPA) staff and employees of the Ford Motor Company (Ford) and one meeting between EPA staff and employees of the Ethyl Corporation (Ethyl).

On October 9, 1991, EPA staff of EPA's Motor Vehicle Emissions Laboratory (MVEL) in Ann Arbor Michigan met with Ford at MVEL. Washington EPA staff participated by telephone. (A list of all participants is attached.) Ford staff described the Ford test program which was conducted on two pairs of Escorts and two pairs of Explorers. (See document IV-D-36 in this docket for a complete description of the Ford test program.) Ford employees emphasized that they believed the deleterious effect of MMT on hydrocarbon (HC) emissions seen in the Ford data is largely a function of total fuel throughput. In this regard, they believed that the Escort was not a worst-case scenario, but that the Explorer vehicles would be a worse-case scenario due to the large fuel throughput. Because of this observation, Ford indicated that Ethyl should have tested trucks in their original test program.

Ford also indicated that the "slave engine" testing performed by Ethyl was possibly inappropriate because feed gas and tailpipe emissions were measured at different times. Ford also suggested that differences between the data collected by Ford and Ethyl may result from the lack of detergent additives in the Ethyl mileage accumulation fuel, different driving cycles for mileage accumulation, and the resulting high fuel flow due to the Ford mileage accumulation cycle.

In response to a question by EPA staff as to why the carbon monoxide (CO) emissions do not increase in parallel with

hydrocarbon (HC) emissions in the Ford data, Ford staff suggested that CO oxidation on the catalyst can be carried out at a single site, while HC oxidation may use several sites.

Ford also indicated that differences in emissions data between the two test programs may, in part, be due to new technology in the Ford-tested Escort vehicles and, additionally, that Ethyl's replacement of injectors may have masked the MMT effect.

On October 15, 1991, staff of EPA met in Washington with staff of Ethyl Corporation, Ethyl Counsel and Systems Application International (SAI), an Ethyl contractor. MVEL EPA staff participated by telephone. (A list of all participants is attached.) An agenda prepared by Ethyl as well as several handouts (attached) describe the presentation by Ethyl at the meeting.

Concerning the agenda item "Response of Systems Applications International to the Ford Comments on Statistical Analysis of the Ethyl Test Data", SAI staff indicated that the data sets used to analyze the Ethyl 48-vehicle fleet data were decided upon prior to the actual analysis. Further, SAI staff stated that SAI analysis of the most expansive data set and the most limited data set yield the same results when evaluated using the "traditional" EPA statistical tests.

Ethyl indicated that more data would be forthcoming on catalyst plugging and light-off, heavy-duty engine testing, and oxygenated fuels.

EPA and Ethyl agreed to hold another meeting in November, 1991.

Attachment

Attachment 1

Participating in October 9, 1991 meeting with Ford:

Environmental Protection Agency:
Rick Rykowski
Paul Machiele
Chris Lindhjem
Dick Lawrence
Bruce Kolowich
Jeff Herzog
Jim Caldwell
David Kortum

Ford Motor Company:
Tom Lasley
Haren Gandhi
Walter Kruecher

Participating in October 15, 1991 Meeting with Ethyl and SAI:

Environmental Protection Agency:
Mary Smith
Richard Lawrence
Bruce Kolowich
Barry Nussbaum
Dwight Atkinson
Jim Caldwell
David Kortum
John Holley
Stanley Stocker-Edwards
Bob Kenney
Dick Lawrence
Paul Machiele
Mike Sklar
Bruce Kolowich
Chris Lindhjem

Ethyl Corporation:
Gary Ter Haar
Jeffrey Smith
Denis Lenane
Don Lynam

Systems Application International:
Ralph Roberson
Alison Pollack

Hunton and Williams:
Bill Brownell

ATTACHMENT 2

AGENDA
Meeting between Ethyl Corporation and U.S. EPA
Regarding the Waiver Application for HiTEC® 3000
October 15, 1991

1. Auto Industry Theories for HC Differences: Ethyl vs Ford Data
   - Differences in Emissions Control Systems
   - Difference in Driving Cycles
   - Differences in Test Fuel

2. Comparison of Ethyl and Ford Test Programs
   - The Ford "fleet" does not represent the national fleet.
   - Ford's test program is narrow in scope and flawed in concept.
   - Ford did not use independent laboratories.
   - Ford did not control variables among vehicles.
   - Ford's generalizations are not credible.

3. Response of Systems Applications International to the Ford Comments on Statistical Analysis of the Ethyl Test Data.

4. Catalytic Converters and Plugging
   - Results of additional analyses
     -- Slave Engine/Light-Off tests by Southwest Research
     -- Metal Analysis & Surface Area
   - Pictures of Catalysts from Ethyl Escorts

5. The Results of Additional Heavy Duty Engine Testing

6. Oxygenated Fuels

7. Future Meetings

AUTO INDUSTRY THEORIES FOR HC DIFFERENCES: ETHYL VS FORD DATA

Ford and GM cite three theories (each discussed below) for the very different HC emission effects associated with use of the Additive in the Ford and Ethyl test programs. None has merit. It is evident that the differences resulted from the varied operating characteristics of the Ford test vehicles, that variability having been compounded by maintenance difficulties, too few vehicles, and, perhaps, the driving habits of the Ford drivers.

1. Differences in Emission Control Systems (Ford)

- Ford speculates that its 1991 Escorts' advanced emission control systems (sequential electronic fuel injection and mass air flow measurement) contributed to the substantial increase in HC emissions associated with use of the Additive in the Ford tests. The 3.8 liter Buicks in Ethyl's 48 car test fleet employed sequential electronic fuel injection and mass air flow similar to that used in Ford's 1991 Escorts. Ethyl's Crown-Vics used the fuel injection system. Ethyl's 2.8 liter Buick systems used the mass air flow. There was very little difference in HC emissions in any of these three Ethyl models, regardless of Additive use. (Attachment 1) Ethyl's 3.8 liter Buicks were arguably the best performers in the fleet. Indeed, Ethyl test vehicles with the most effective emission control systems for reducing HC emissions also had the lowest increases in HC emissions when using the Additive.

- Advanced emission control technology has eliminated significant adverse effects of the Additive on HC emissions. The 1977-78 CRC test program (63 cars operated 50,000 miles each) showed an average difference in HC emissions between clear and Additive-fueled vehicles of 0.077 gpm. More than ten years and an entirely new set of emission standards later, the difference dropped to 0.018 gpm in Ethyl's test program (48 cars operated 75,000 each). In startling, paradoxical contrast to that trend, Ford's Additive-fueled Escorts averaged 0.117 gpm greater HC emissions than Ford's clear-fueled Escorts over a 100,000 mile test course. Ford's two clear Escorts averaged 0.26 gpm (13%) less HC than Ethyl's three Escorts; Ford's two Additive Escorts averaged 0.81 gpm (39%) more HC than Ethyl's three. (Attachment 2.) **All of the HC increase attributable to the Additive was accrued within the initial 50,000 miles of its use, contrary to the implication in Ford's statement that "the greatest catalyst efficiency deterioration (for HC) from the Ford test vehicles occurred between 50,000 and 100,000 miles".** (Use of the Additive in the Escorts in Ford's program had no adverse effect on NOx and CO catalytic converter efficiencies.)

- In the same vein, it is difficult to reconcile the above cited Ford statement about "greatest catalyst deterioration" with Ford's own data on the Explorers. One of the two Additive Explorers had a marked HC decrease (.161 gpm) between 85,000 and 105,000 miles. The other Explorer performed superbly up to 55,000 miles after which it had maintenance problems, performed in a highly bizarre manner, and had no HC measurements made on it until 105,000 miles. (Attachment 3)

- Manganese exposure rates point to other inconsistencies in Ford's claims regarding catalyst deterioration. Given the average 50 mph speeds in Ford's tests, it can be assumed that manganese consumption for the Explorers was as much as three times that for Escorts. Yet note (Attachment 3) how well Explorer 306, "loaded with manganese", performed for 50,000 miles. Its HC emissions were very close to the very low HC emissions recorded for clear Explorer 305 and both clear Escorts; markedly better than those of clear Explorer 307 and both Additive Escorts. (The bizarre explosion of HC emissions from Additive Explorer 306 after 55,000 miles, was almost certainly due to maintenance problems, particularly in light of Additive Explorer 304's marked HC decline after 85,000 miles.)

2. Differences in Average Speeds in Driving Cycles (Ford & GM)

- The Additive has been used in unleaded gasoline in Canada for well over ten years at concentrations higher than 1/32 gpg. No reports of unusually poor emission performance have risen, notwithstanding the wide variety of field operating conditions to which the Additive in actual use has been subjected. Letters from major Canadian refineries (Attachments 4 and 5) confirm this observation.

- From what Ethyl has been able to ascertain of the Ford protocol to date, it is not considered that Ford's driving cycle was sufficiently atypical to be a factor in the HC differences. Nevertheless, the cycle used by Ethyl is that specified for certification of automobiles and therefore the cycle appropriate for fuel additive waiver test programs under the Agency's existing fuel additive waiver guidelines.

- Ethyl's extreme driving cycle test (100 mph; 25,000 miles) of Chevrolet Corvettes showed no HC results such as Ford's.

3. Differences in Detergent Presence in Test Fuel (Ford & GM)

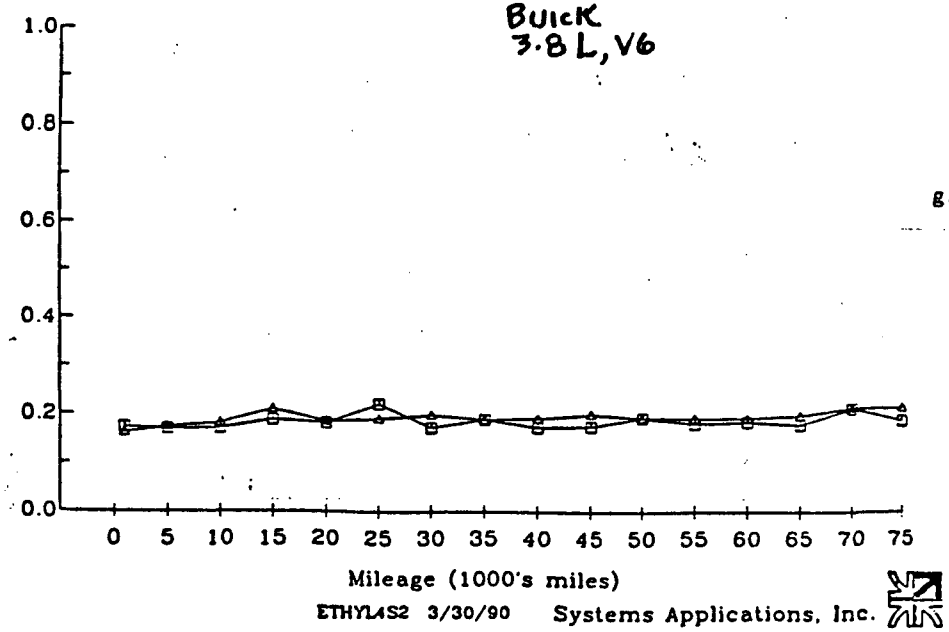
- The purpose of detergent additives is to inhibit fuel system deposits. Since one of the major concerns expressed by the auto industry is manganese engine deposits associated with use of the Additive, Ethyl's use of a fuel without a detergent additive (Howell EEE) provided a worst-case examination of the Additive's potential emission effects; informal advice from the technical staff of API's refinery directorate agrees.

- Ethyl has tested the Additive on Chevrolet Corvettes using fuel containing a detergent and a very extreme driving cycle (100 mph constant speed for 25,000 miles) without showing HC emission results anything like the Ford test program.

- The 1977-78 CRC tests used a base fuel containing a detergent, yet the average HC difference in the CRC fleet (.077 gpm in vehicles with much less effective emission control systems) was significantly less than 0.117 gpm Ford reported for its Escorts.

Model I

BUICK
3.8 L, V6



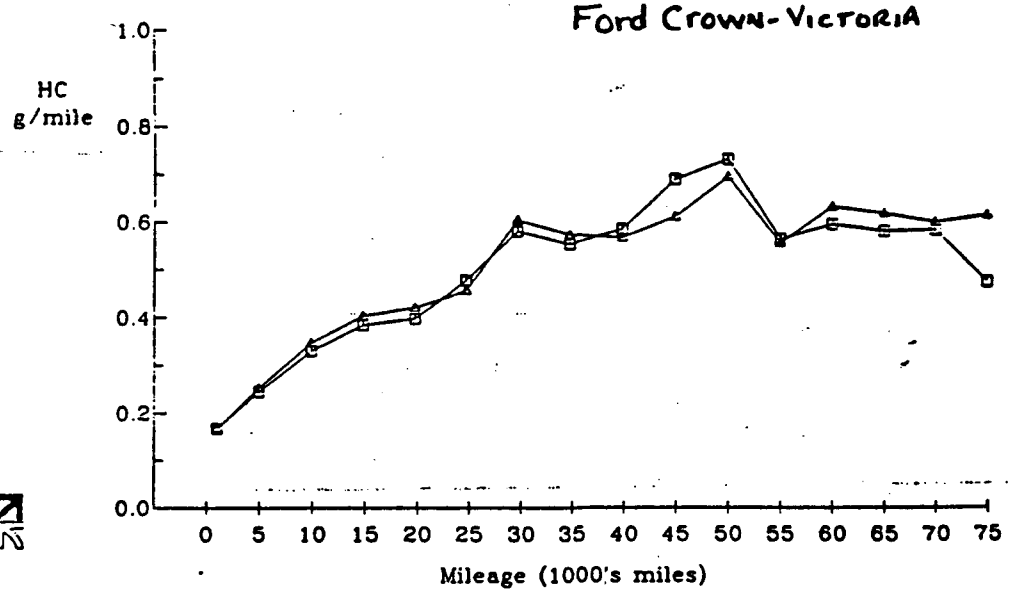
ETHYL4S2 3/30/90 Systems Applications, Inc.

B-52

Average Tailpipe Hydrocarbon Emissions

Model F

Ford Crown-Victoria

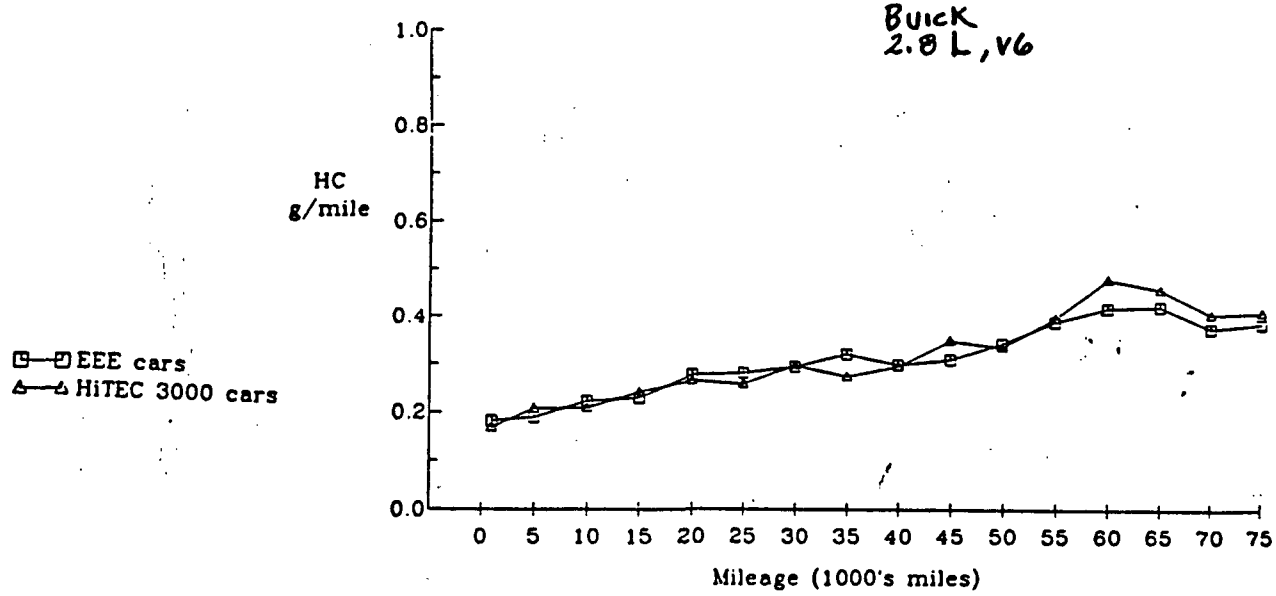


ATTACHMENT 1

Average Tailpipe Hydrocarbon Emissions

Model H

BUICK
2.8 L, V6



HC EMISSIONS SUMMARY

Average Emissions (gm/mile)

Test/Fleet Description	Mileages (000)	HiTEC Fuel (1/32gpg Mn)	Clear Fuel	Difference (HiTEC-Clear)
CRC 1977-78 Test	.3-50	0.449	0.372	0.077
Ethyl 1988 Fleet[1]	1-75	0.305	0.285	0.020(1)
Ethyl's 1988 Escorts[2]	1-75	0.207	0.197	0.010
Ford's 1991 Escorts[2,3]	5-105	0.288	0.171	0.117

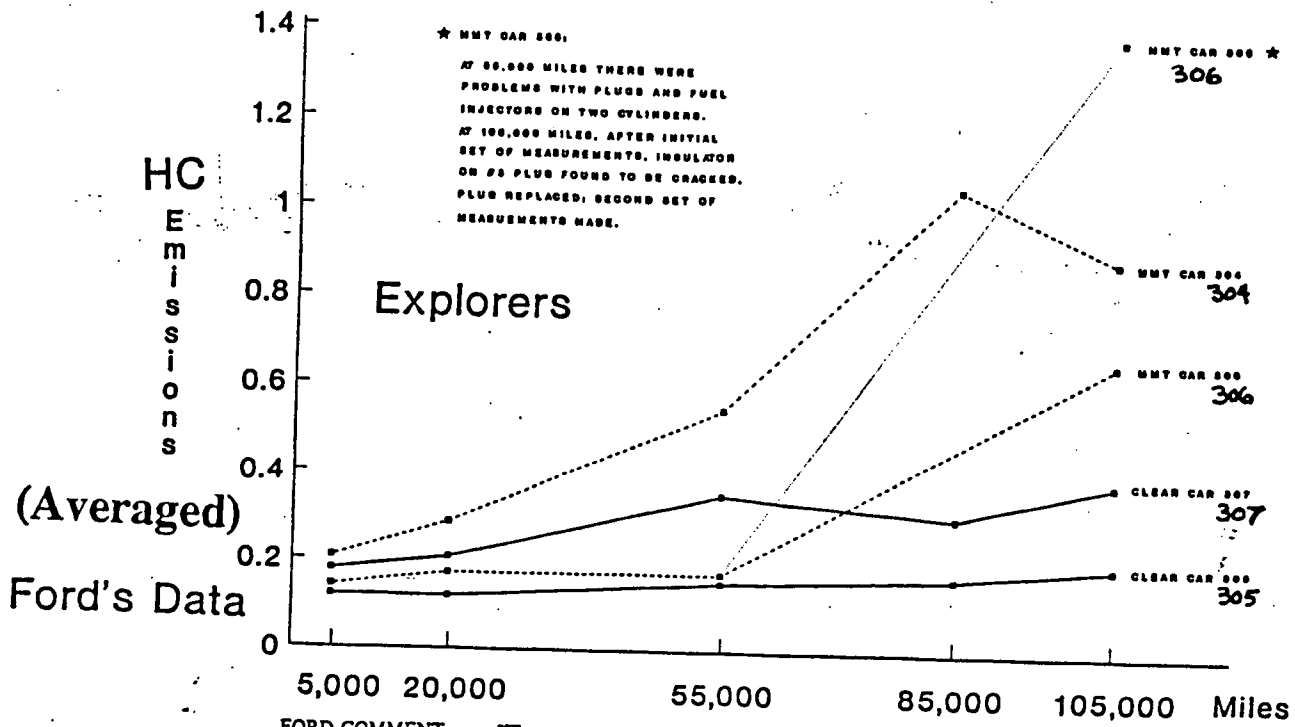
(1) When emissions are weighted by 1988 fleet sales, difference is 0.018 gpm

(2) Averages do not include baseline tests (i.e., 1,000 mile data for Ethyl; 5,000 mile data for Ford.)

(3) Absolutely no increases in HC emissions from either HiTEC® or Clear fuel were noted between 55,000 and 105,000 miles.

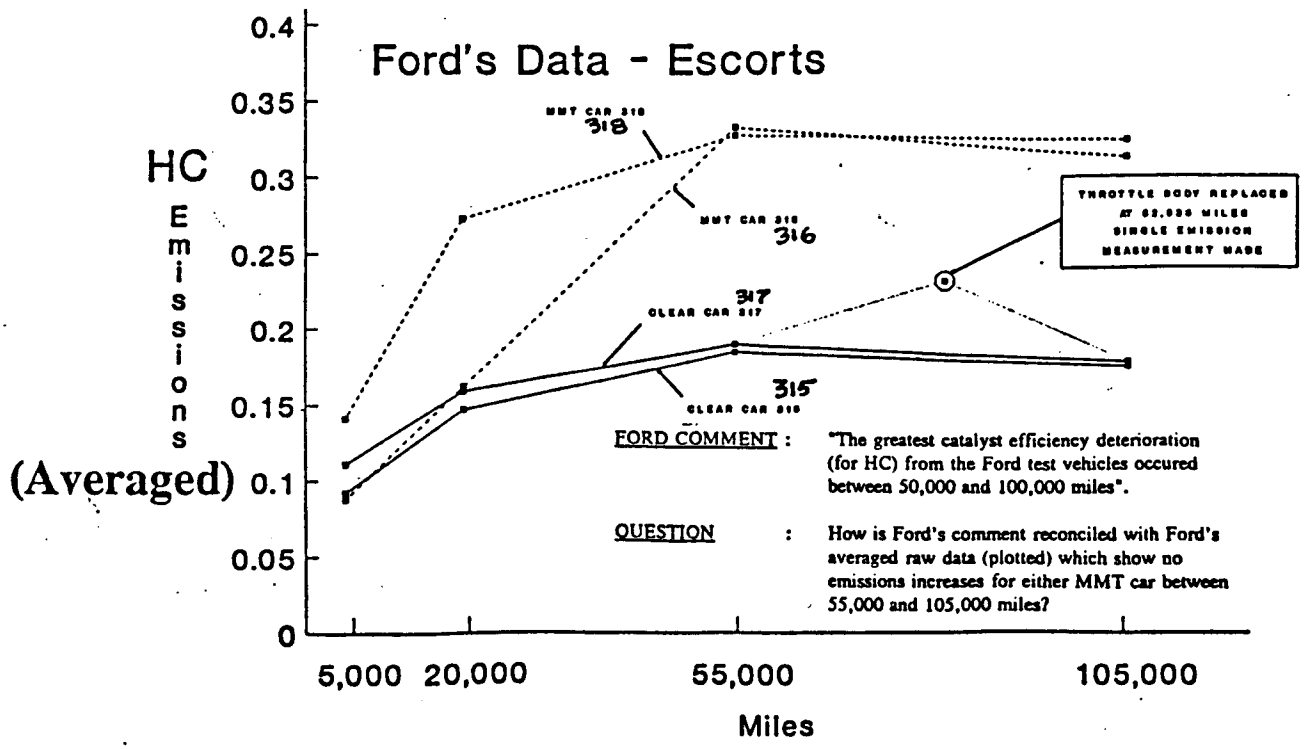
ETHYL CORPORATION
10 October 1991

Attachment 2



FORD COMMENT : "The greatest catalyst efficiency deterioration (for HC) from the Ford test vehicles occurred between 50,000 and 100,000 miles".

QUESTION : How is Ford's comment reconciled with Ford's averaged raw data (plotted) which show a marked HC decrease for one MMT car after 85,000 miles and an extremely erratic performance of the other MMT car?



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QUESTION : How is Ford's comment reconciled with Ford's averaged raw data (plotted) which show no emissions increases for either MMT car between 55,000 and 105,000 miles?

ATTACHMENT 3

Petro-Canada Products
P.O. Box 2844
Calgary, Alberta T2P 3E3
Telephone (403) 296-8000
Telex 03-825753

Produits Pétro-Canada
C.P. 2844
Calgary (Alberta) T2P 3E3
Téléphone (403) 296-8000
Télex 03-825753

A-91-46
IV-D-20

ATTACHMENT 4

PETRO-CANADA

October 2, 1991

Environmental Protection Agency
Public Docket A-91-46
Air Docket (LE-131)
401 M Street S. W. Room M-1500
Washington, D. C. 20460

OCT - 3 1991

re:Docket A-91-46 (Ethyl Hitec 3000 MMT Waiver Application)

Petro-Canada is one of the largest retailers of gasoline in Canada and attached is a copy of our annual report which describes our operations.

In support of Ethyl's waiver application, we at Petro-Canada wish to relate our experience with the use of MMT in unleaded gasoline.

In common with the other major gasoline producers, we have sold MMT containing gasoline in Canada since 1976 at up to twice the concentration applied for in the above waiver. Thus Canadian automobiles have collectively been exposed to MMT for many millions of miles and many individual vehicles to well over 100000 miles of operation. We have not had a single complaint referencing catalyst plugging.

In addition, our research department has examined a number of catalysts from our high mileage in-house test fleet without finding any evidence of catalyst plugging. In addition our research department have had tail pipe emissions carried out by the Ministry of Transportation of Ontario on this fleet and on two Mercury Sables one of which was run on MMT free gasoline and the other on MMT containing gasoline for 80000 km. All the fleet with the exception of one car who's catalyst was virtually destroyed because of a non MMT related problem met the emission standards the cars were designed for after up to 160000 km of operation on MMT containing gasoline. The results from the testing of the two Sables which were matched cars run on identical service on matched dynometers were very similar with the emissions from the MMT free gasoline being numerically slightly poorer than with the MMT gasoline.

We have discussed the issue several times with the auto manufacturers and are aware of their concerns; however they have not submitted any evidence to us that MMT is associated with catalyst plugging or other failure.

In summary, Petro-Canada has found MMT to be a cost effective means of achieving the required octane levels in unleaded gasoline. We are not aware of any catalyst related problems that would preclude its use at even twice the concentration applied for in the waiver application.

Yours truly,

R. E. Dart
Senior Director Refining

attachment

cc Mary T. Smith
Director Field Operations and Support Division (EN-397F)
U. S. Envronmental Protection Agency
401 M Street S. W.
Washington, D. C. 20460

P.12

A-91-46
IV-D-16

Petroleum Products Division

Imperial Oil Limited
55 St. Clair Avenue West
Toronto, Ontario
Canada M5W 2J8

D.R. Purdie
Vice-President
Business Services

T.R. Clapp
Director - Safety &
Environmental Affairs

Imperial Oil

VIA COURIER

October 1, 1991

R & D - Hazardous Substances (MMT)
GOV - US EPA

Environmental Protection Agency
Public Docket A-91-46
Air Docket (LE-131)
401 M Street S.W., Room M-1500
Washington, D.C.
20460

-2 '91

Dear Madam or Sir

This letter is intended to provide the E.P.A. with information concerning our experience in Canada with the gasoline additive MMT. Imperial Oil Limited, through its downstream refining and marketing arm, is the largest gasoline refiner and retailer in Canada. With some minor exceptions, we have used MMT in our unleaded gasoline grades continuously since the late 1970's. The maximum allowable level of MMT in Canada is 18 mg/litre which is twice the limit which Ethyl Corporation has applied for in its U.S.A. waiver application. Imperial Oil's typical levels are in the 8-12 range, and would average about 10 mg of Mn per litre.

Imperial Oil Limited has no direct business incentive to either support or oppose the current Ethyl Corporation waiver application in the U.S.A. However, we recognize that the E.P.A. ruling will have a bearing on the future use of MMT in Canada. It is, therefore, important to us that this issue be decided as objectively as possible.

As we stated in a July 18th, 1990 letter to E.P.A. concerning Ethyl's 1990 waiver application, Imperial Oil has reviewed the published information on this subject, and is a "knowledgeable user". We have followed the technical and political arguments surrounding MMT, and have worked with several industry and government groups that have studied and reviewed MMT use in unleaded gasoline. These include a 1986 review by the Canadian General

.../2

Standards Board and an independent scientific review by the Royal Society of Canada Commission on Lead in the Environment. The Royal Society concluded that MMT was a viable octane alternative, along with MTBE/ethers and ethanol/alcohols. Lead has been eliminated from Canadian gasolines, and MMT is permitted in all grades.

The CGSB study concluded that MMT use should continue to be allowed and recognized in the CGSB National Standard for gasoline but that its use should remain open to challenge with whatever new information that becomes available. This has proven to be a workable approach in Canada that we expect to continue for the foreseeable future.

MMT is added to our gasoline in the final blending stage. Although its use is not absolutely necessary in order to achieve desired octane levels, it is nonetheless, a cost-effective octane enhancing agent. Through its use, we are able to reduce overall crude oil consumption, and reduce the severity of refining processes used to make gasoline. In particular, the naphtha reforming process is less severe, which contributes to lower overall levels of aromatic constituents in gasoline. Without the use of MMT gasoline manufacturing costs, which are ultimately borne by the consumer, would rise, and other potentially adverse environmental impacts could occur.

Imperial Oil's Canadian experience with the use of MMT has been very positive. Our Canadian Field experience and technical service studies have led us to conclude that MMT does not foul spark plugs, poison oxygen sensors, plug catalyst beds or otherwise cause engine wear or damage.

Imperial Oil, with over ten years of Canadian experience, has found MMT to be a valuable and cost effective octane enhancer for all grades of gasoline. We believe it is suitable for use across the total automotive gasoline spectrum, and we believe that our customers have been well served by its use.

Yours very truly

T. R. Clapp

WRB:jt

LEPA.wrb

c.c.: M. T. Smith - U.S. Environmental Protection Agency
D. C. Wilson - Ethyl Canada
H. F. Wilkinson - Esso Petroleum Canada

ATTACHMENT 15

COMPARISON OF ETHYL AND FORD TEST PROGRAMS

A direct comparison of the Ethyl and Ford test programs suggests that the Ford test program is not entitled to much, if any, weight:

- The Ford "fleet" does not represent the national fleet -- Ethyl tested a total of 48 cars (six cars from eight different vehicle models) representing over 50 percent of the vehicles sold in 1988. Ford, by Contrast, tested a total of 8 vehicles (four cars from two different vehicle models) accounting for only about three percent of vehicle sales in 1991, and one model of which was a "prototype" vehicle not representative of any certified automobiles.

- Ford's test program is narrow in design and flawed in concept -- The Ethyl test program obtained more than 2100 emission measurement values based on testing conducted every 5000 miles up to 75,000 miles on 48 test vehicles. Ford, by contrast, obtained only about 120 emission measurement values since it tested its eight test vehicles at only three or four intervals over the course of 100,000 miles. By virtue of the far more extensive testing conducted in the Ethyl test program, Ethyl was better able to isolate the emission effects associated with the Additive. Ford's own data shows, for example, that its test vehicles encountered serious maintenance difficulties which, in some instances, may have been left uncorrected for as many as 50,000 miles, and which had a very substantial impact on emission performance.

- Ford did not use independent laboratories -- To insure the integrity of the test data and analyses, independent laboratories conducted the Ethyl test program on Ethyl's behalf and completed the basic statistical analyses of the test data. All of the Ford testing and analysis, by contrast, was conducted "in-house".

- Ford did not control variables among vehicles -- Ethyl's test vehicles, whether operating on fuel with or without the Additive, show very little variation in HC emissions within car models. (Attachment 1) By contrast, Ford's prototype Explorer shows wide differences in HC emissions **for both clear and Additive test fuels** (Attachment 2), suggesting that the Additive was not the critical variable affecting emissions. Indeed, catalytic converter efficiency data supplied by Ford bears this out. The converter efficiency **of the two clear fuel** Ford Explorers at the 100,000 mile interval differed by seven percent, the same difference Ford attempts to attribute to the Additive based on average differences for the clear and additive-fueled Ford test vehicles at the 100,000 mile interval.

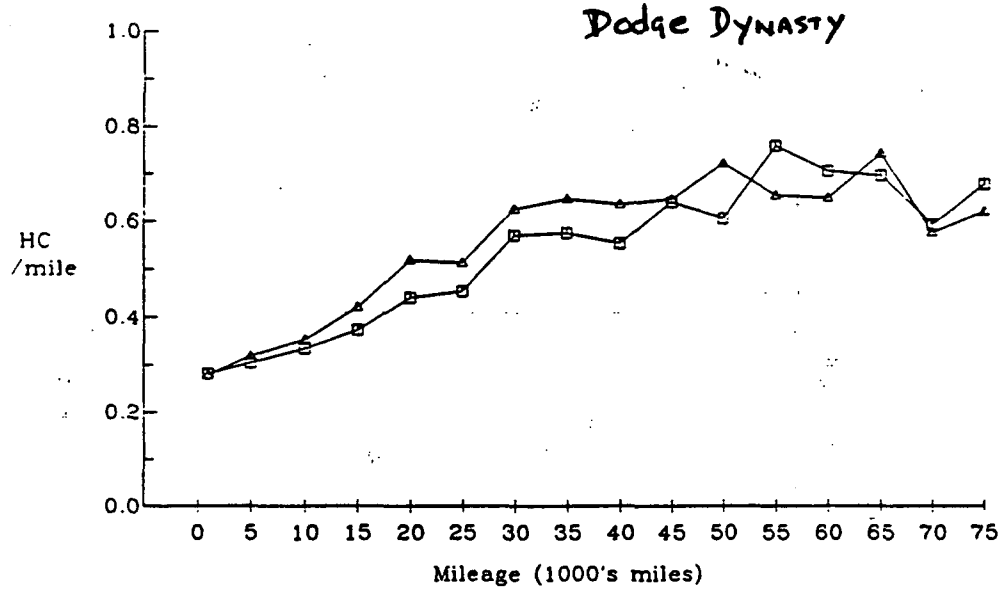
- Ford's generalizations are not credible -- Ford's attempt to generalize the effects of the Additive from its test data to either a particular model or the national car fleet cannot be supported. Ford's overall test results generally reflect the emission performance of a single test vehicle; and in some cases, a single mileage interval. Moreover, Ford's plots of emissions in its 3 October submission distort both trends and results (Attachment 2 and 3).

ATTACHMENT 1 (1 of 2 pp)

Average Tailpipe Hydrocarbon Emissions

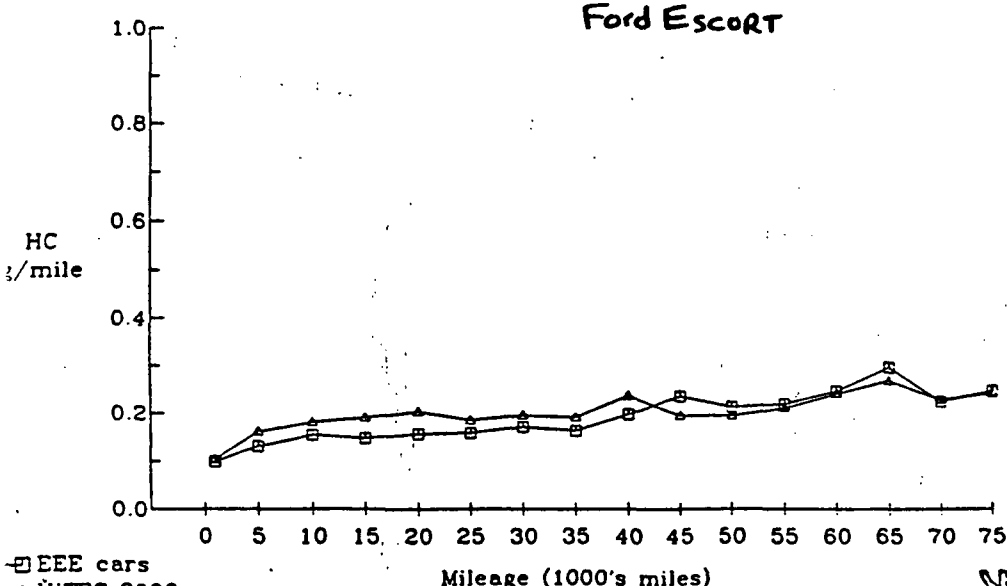
Model D

Dodge Dynasty



Model E

Ford Escort



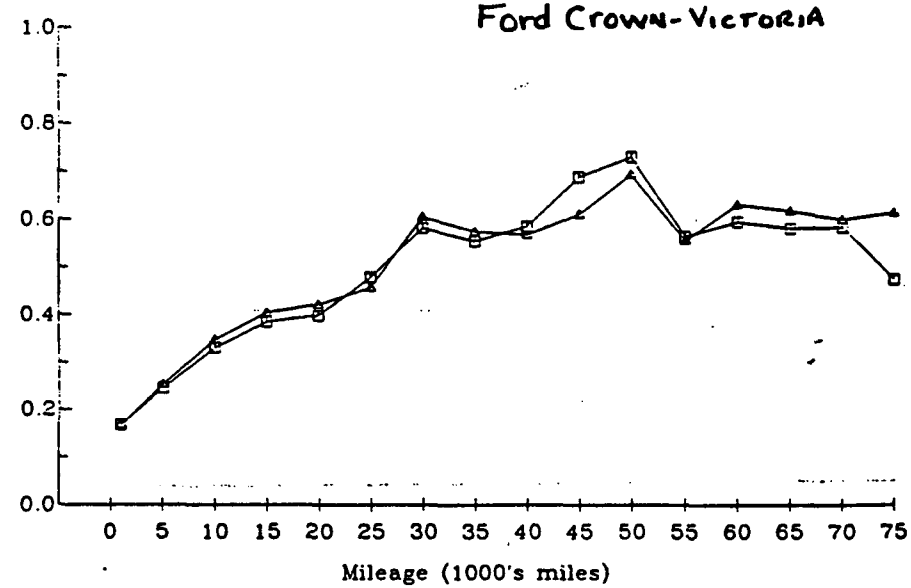
ETHYL4S2 3/30/90 Systems Applications, Inc.

B-49

Average Tailpipe Hydrocarbon Emissions

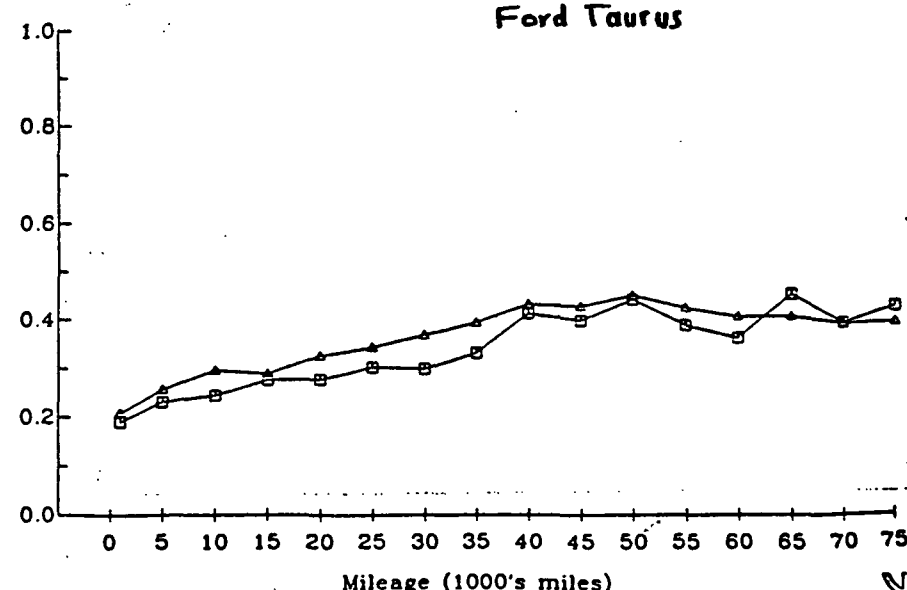
Model F

Ford Crown-Victoria



Model T

Ford Taurus



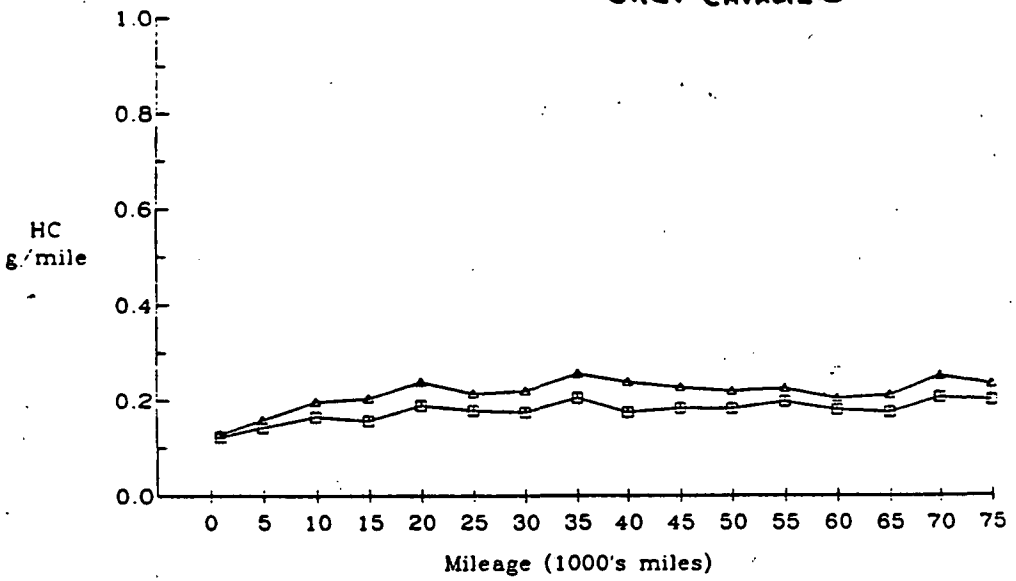
ETHYL4S2 3/30/90 Systems Applications, Inc.

B-50

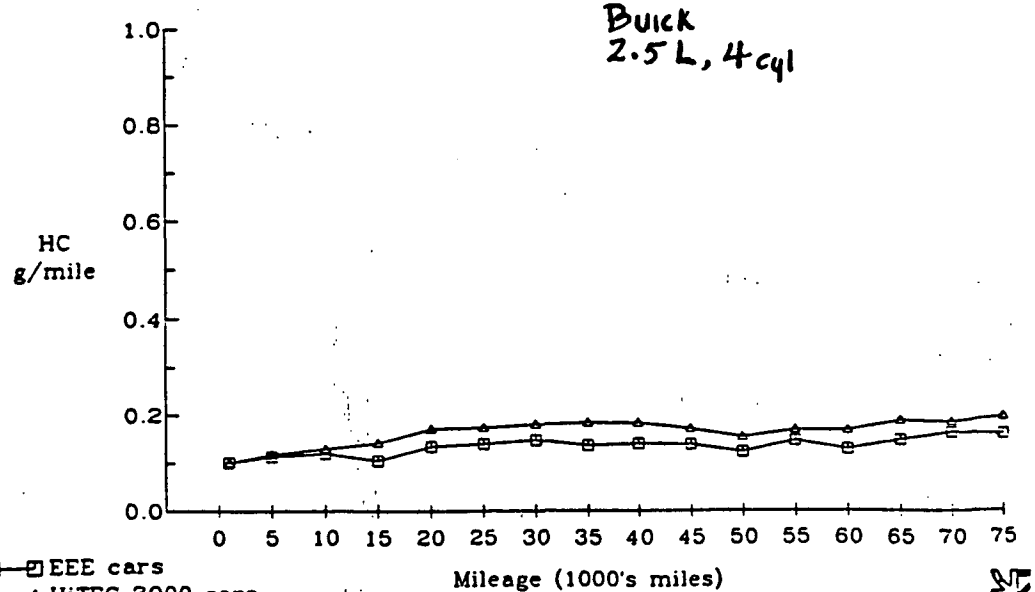
ATTACHMENT 1 (2 of 2 pp)

Average Tailpipe Hydrocarbon Emissions

Model C
Chev Cavalier



Model G
Buick
2.5 L, 4 cyl

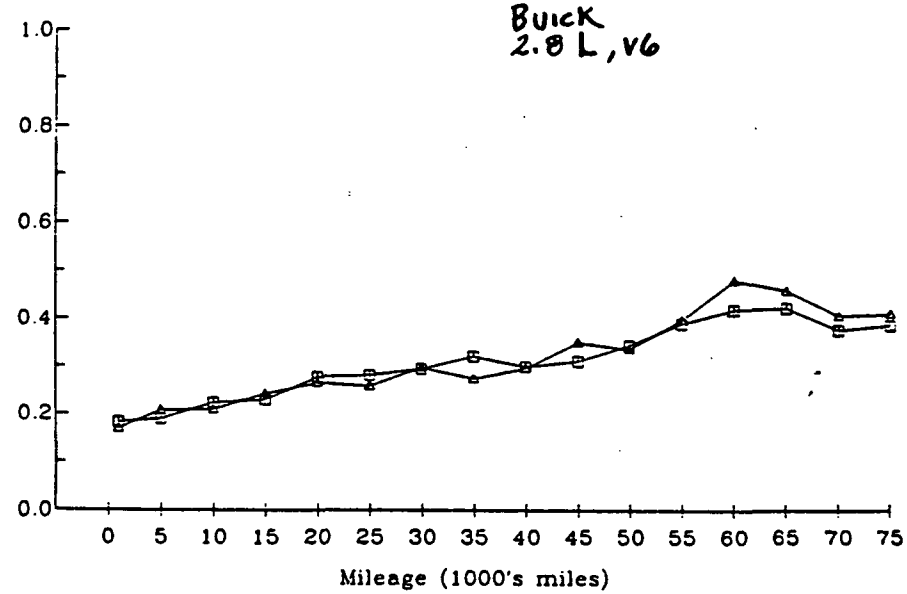


EEE cars
HiTEC 3000 cars

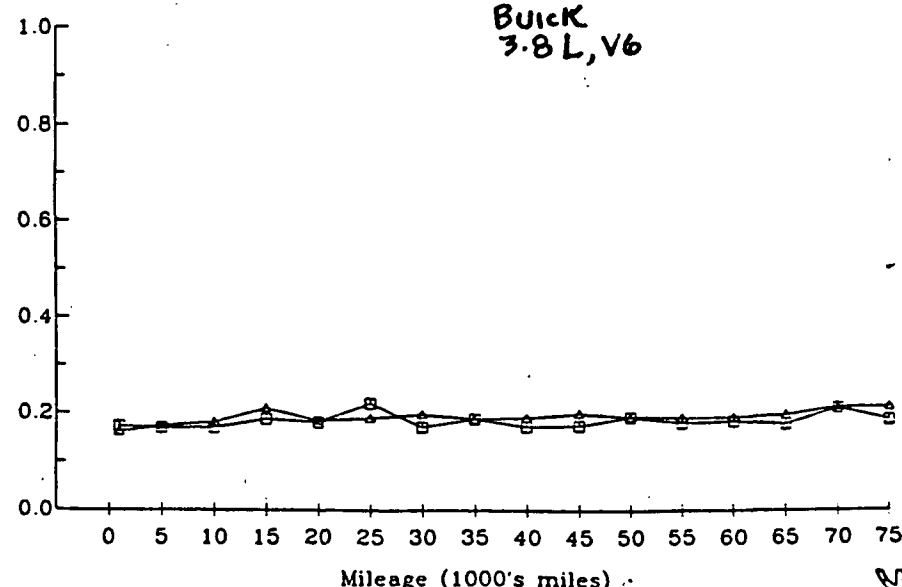
ETHYL4S2 3/30/90 Systems Applications, Inc.

Average Tailpipe Hydrocarbon Emissions

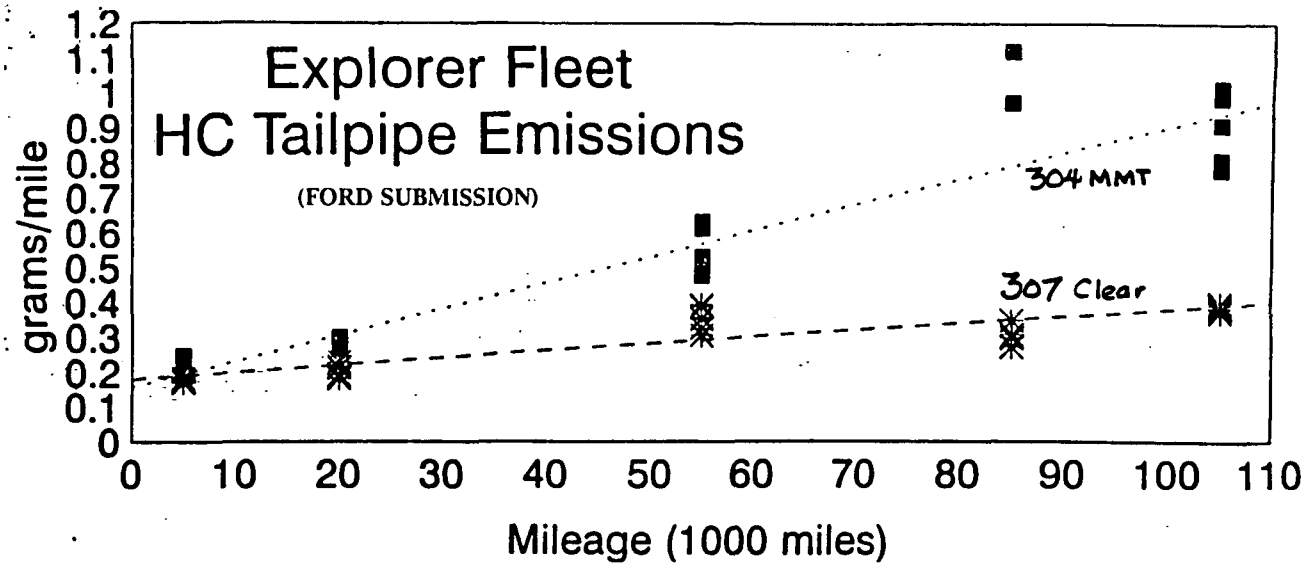
Model H
Buick
2.8 L, V6

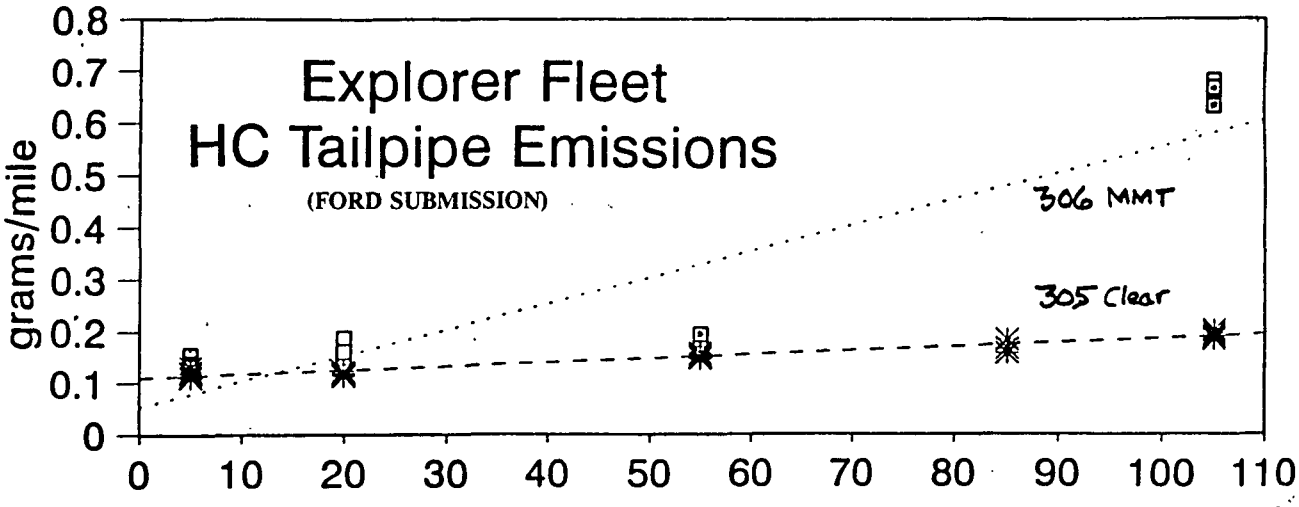


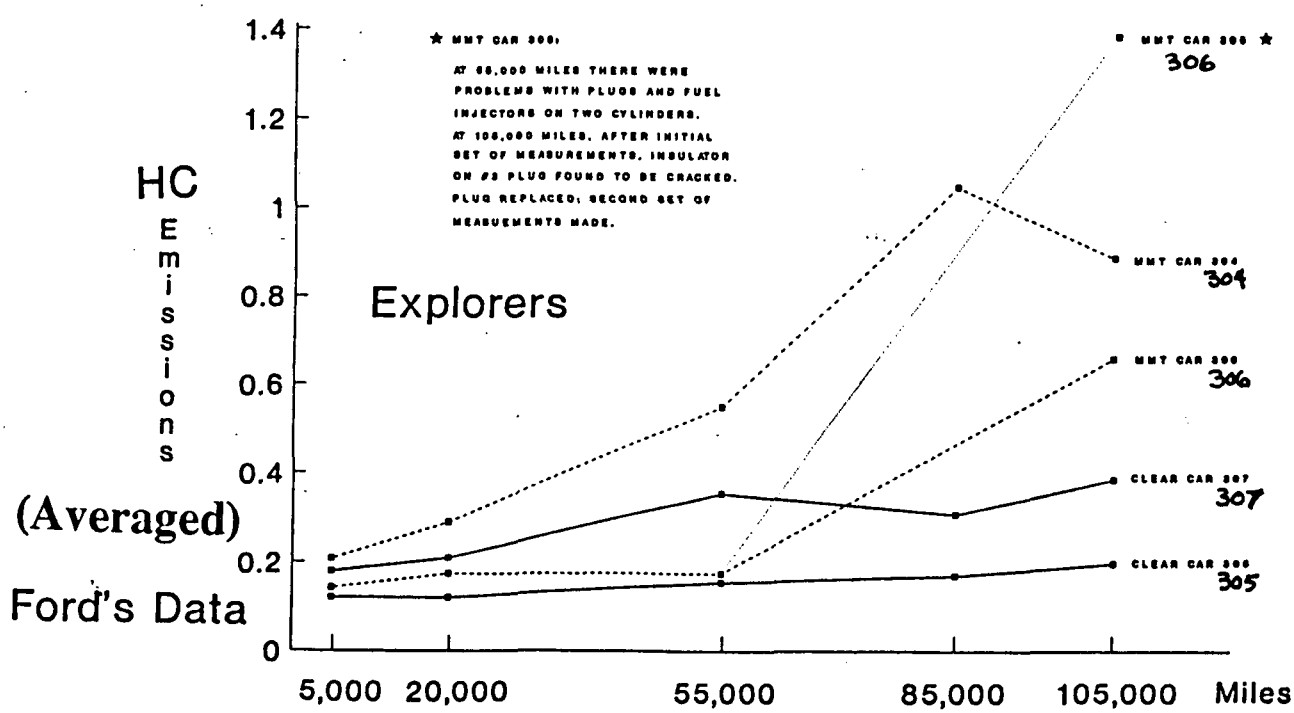
Model I
Buick
3.8 L, V6



ETHYL4S2 3/30/90 Systems Applications, Inc.







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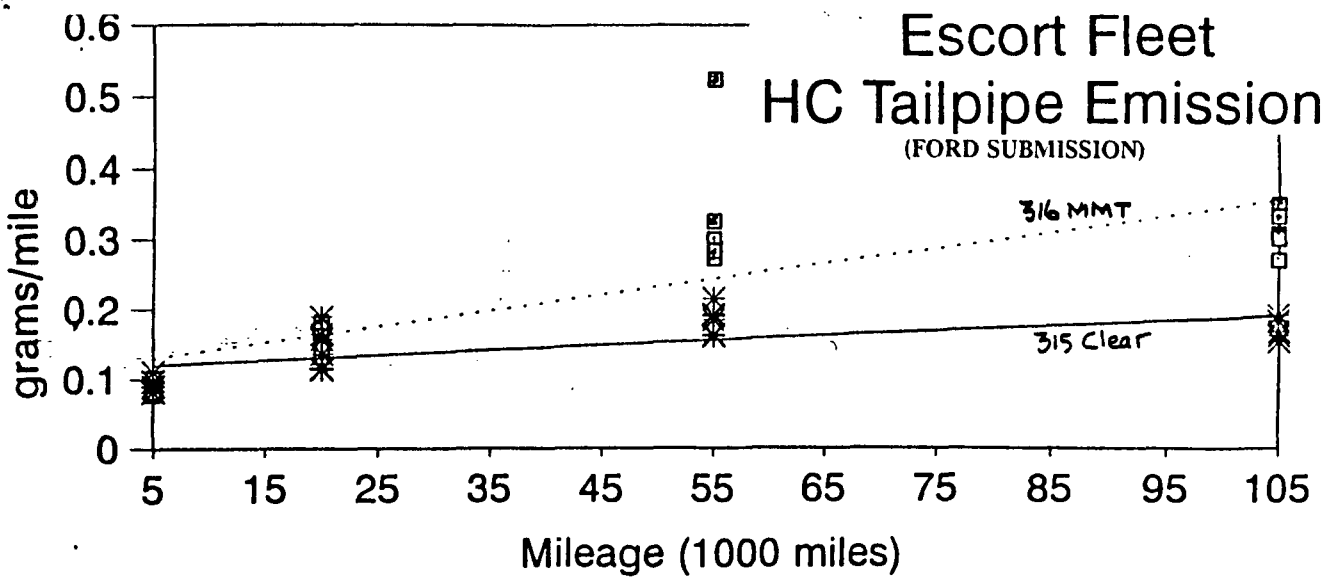
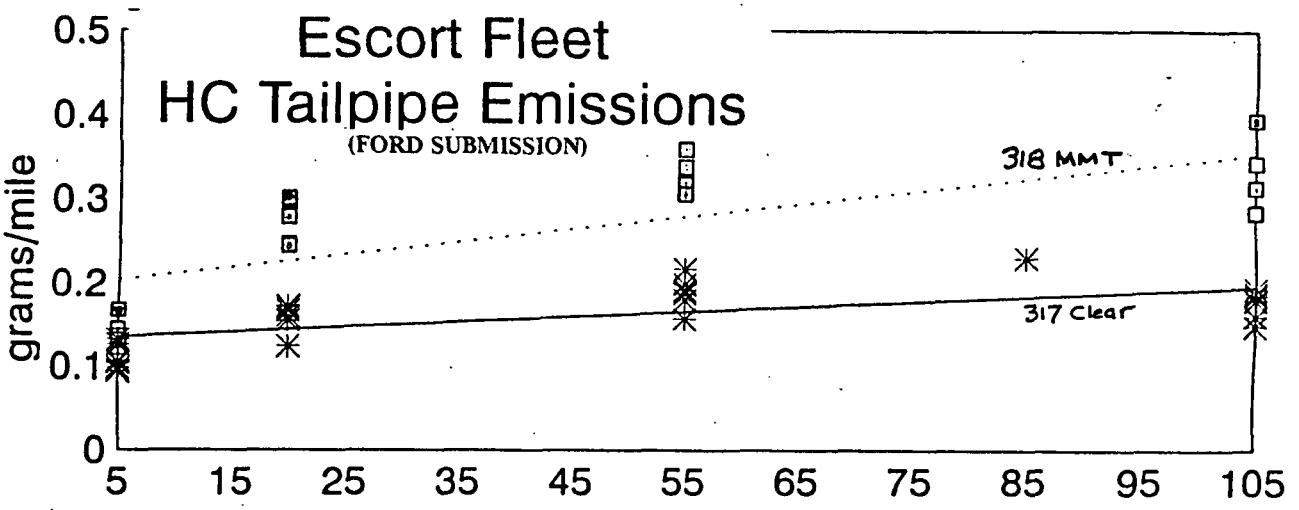
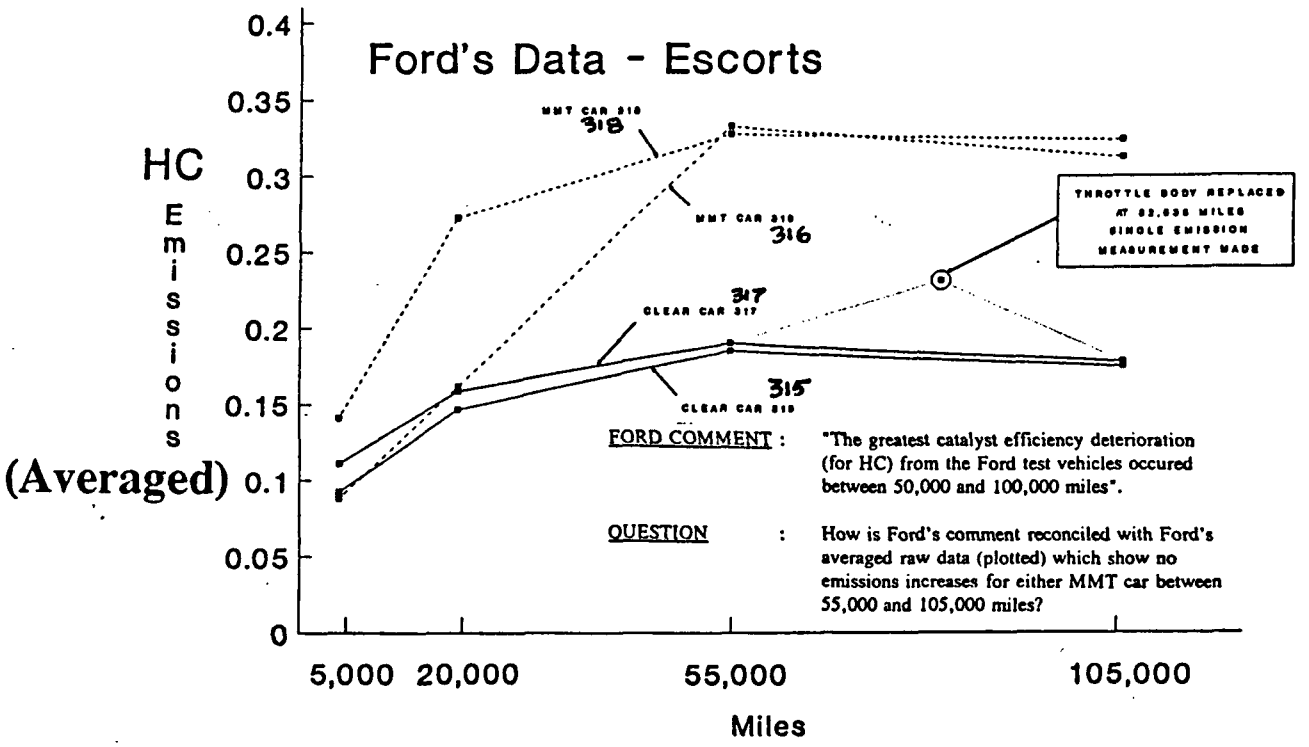
ATTACHMENT 2





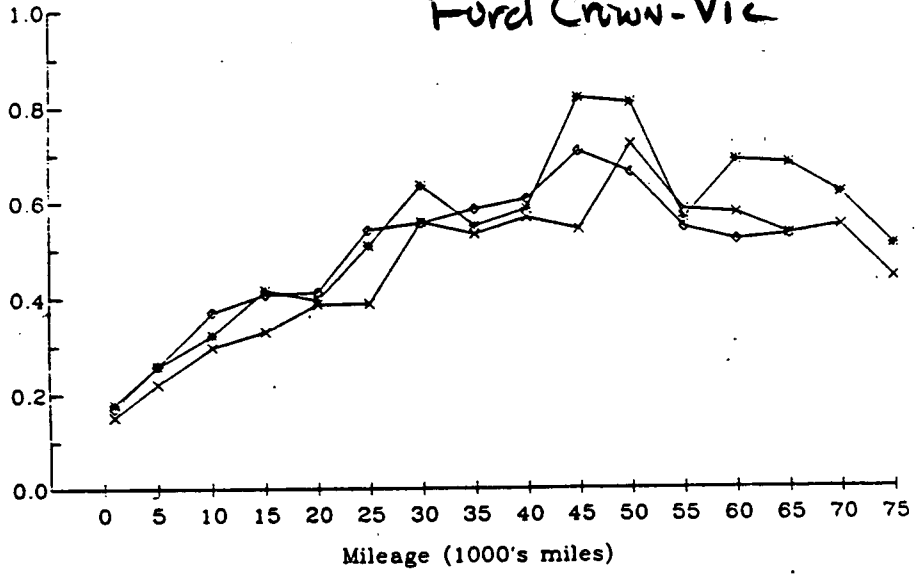


ATTACHMENT 3

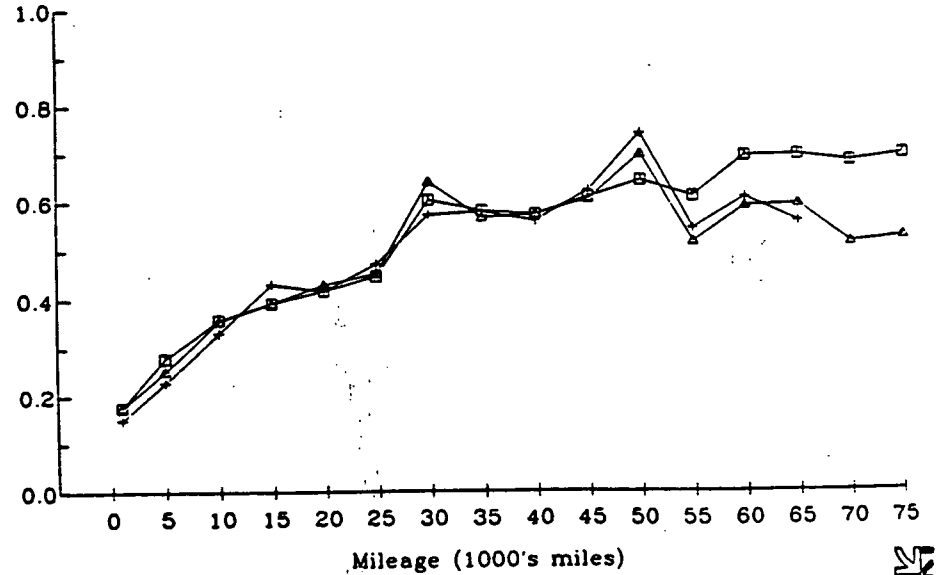
Average Tailpipe Hydrocarbon Emissions
for Model Group F

EEE cars

Ford Crown-Vic



HiTEC 3000 cars



ETHYLAS2 3/30/90 Systems Applications, Inc.

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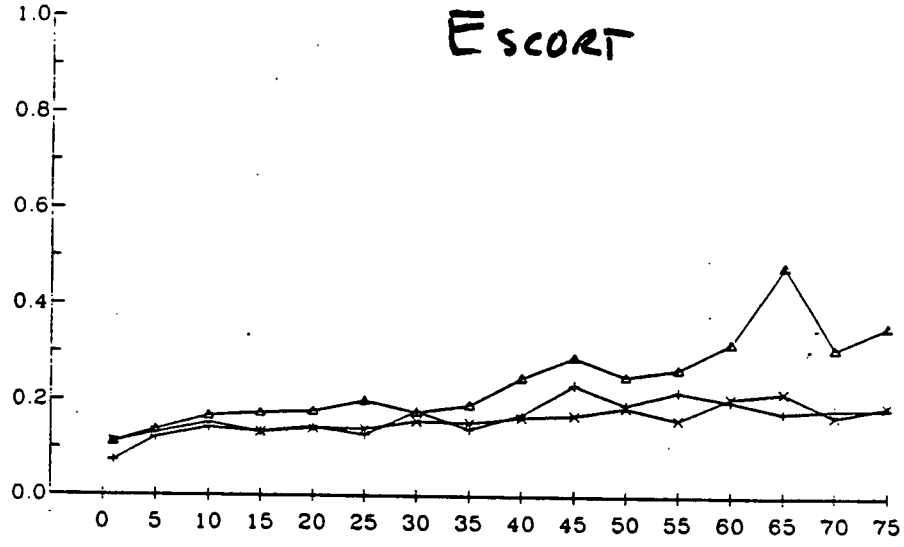
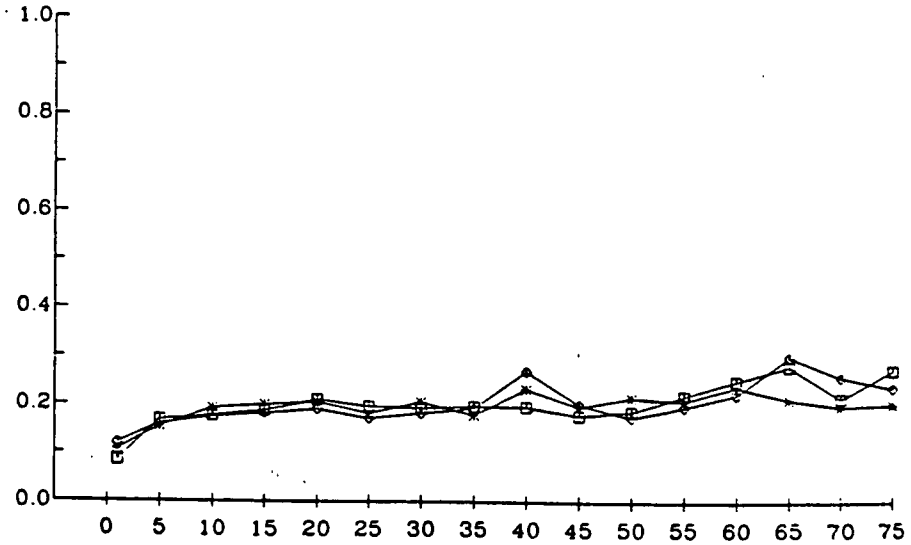
Average Tailpipe Hydrocarbon Emissions
for Model Group E

EEE cars

Escort



HiTEC 3000 cars



ETHYLAS2 3/30/90 Systems Applications, Inc.

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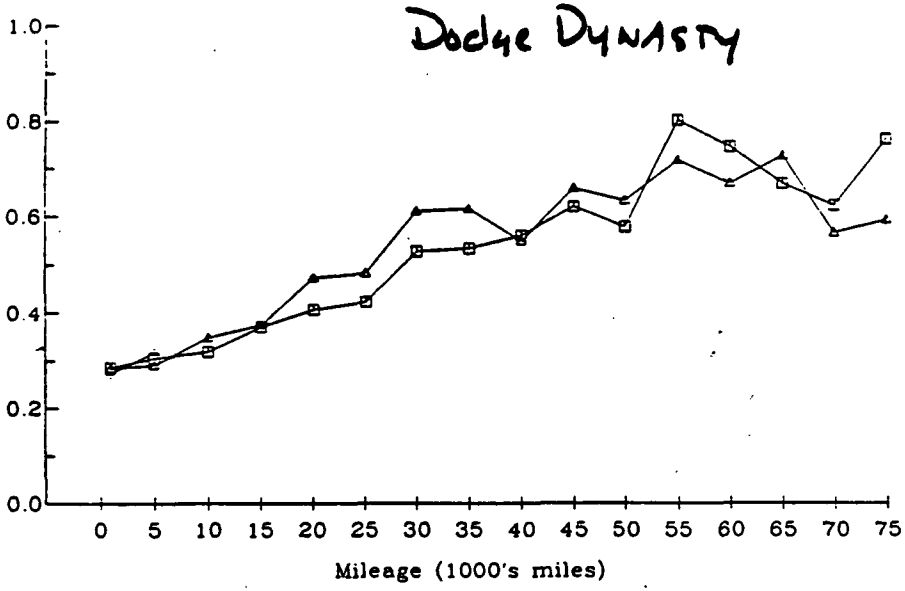
Car # 1
Car # 2
Car # 3
Car # 4
Car # 5
Car # 6

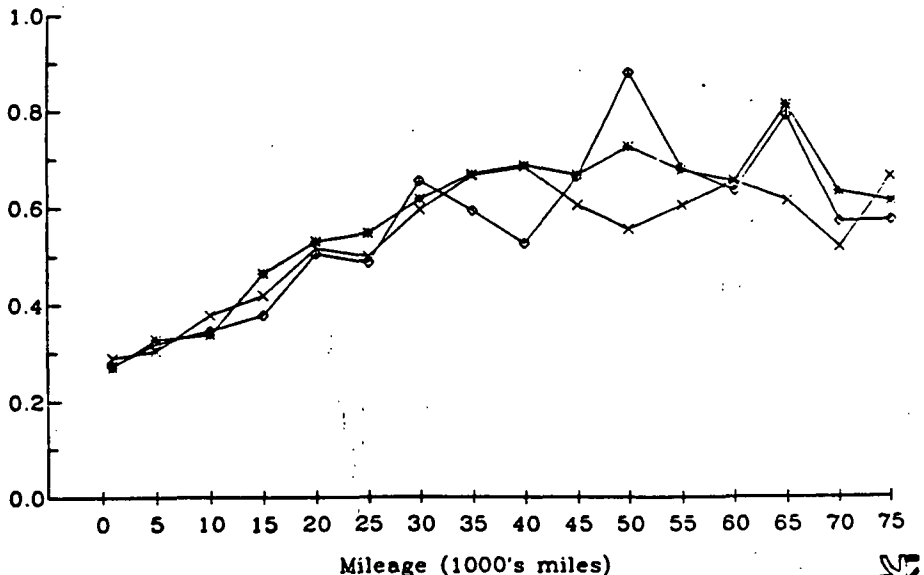
Average Tailpipe Hydrocarbon Emissions
for Model Group D

EEE cars

Dodge Dynasty



HiTEC 3000 cars



ETHYL4S2 3/30/90 Systems Applications, Inc.

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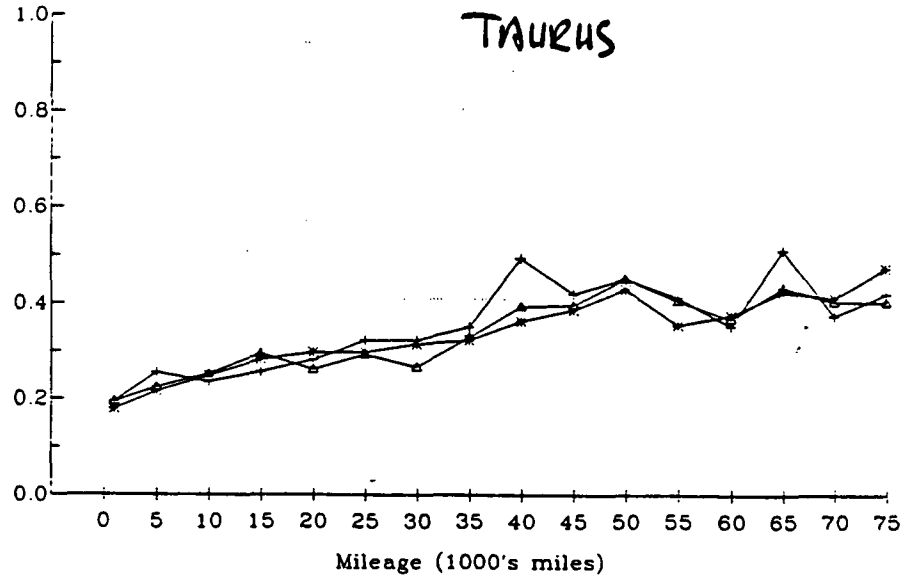
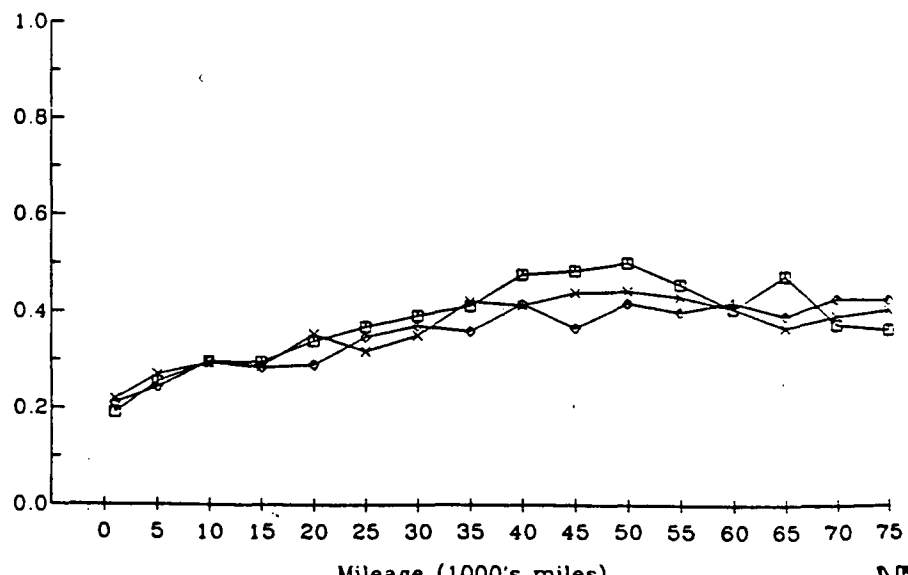
Average Tailpipe Hydrocarbon Emissions
for Model Group T

EEE cars

Taurus



HiTEC 3000 cars



ETHYL4S2 3/30/90 Systems Applications, Inc.

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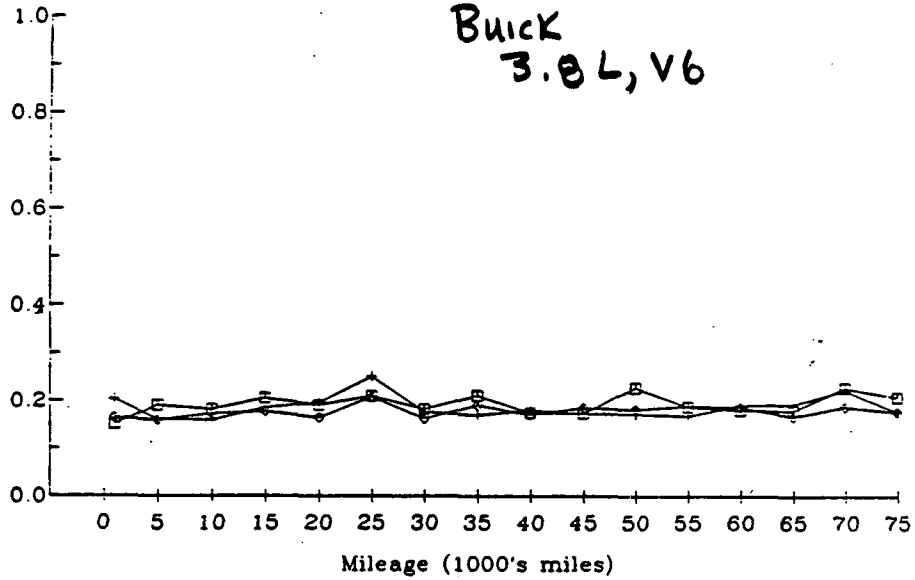
Car # 1 Car # 4
Car # 2 Car # 5
Car # 3 Car # 6

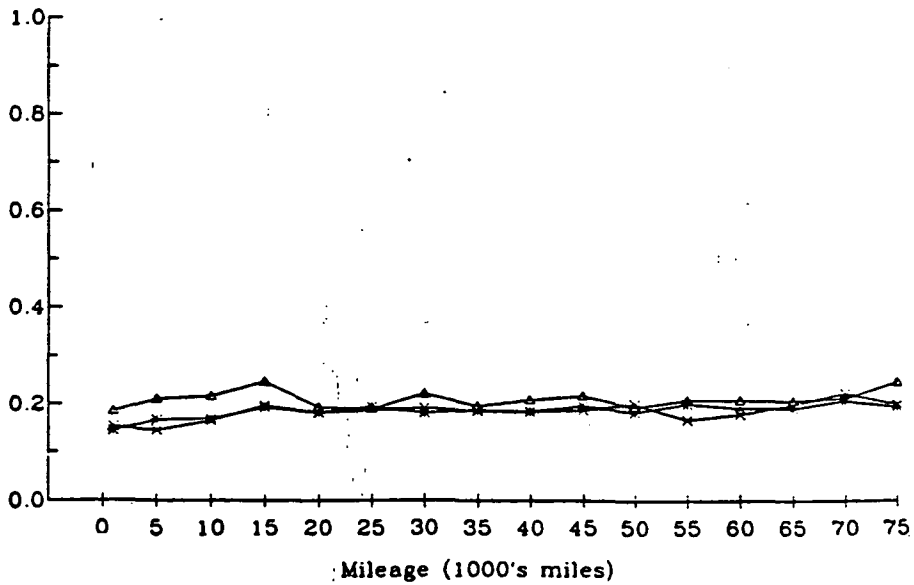
Average Tailpipe Hydrocarbon Emissions for Model Group I

EEE cars

BUICK 3.8L, V6



HiTEC 3000 cars



ETHYL4S2 3/30/90 Systems Applications, Inc.

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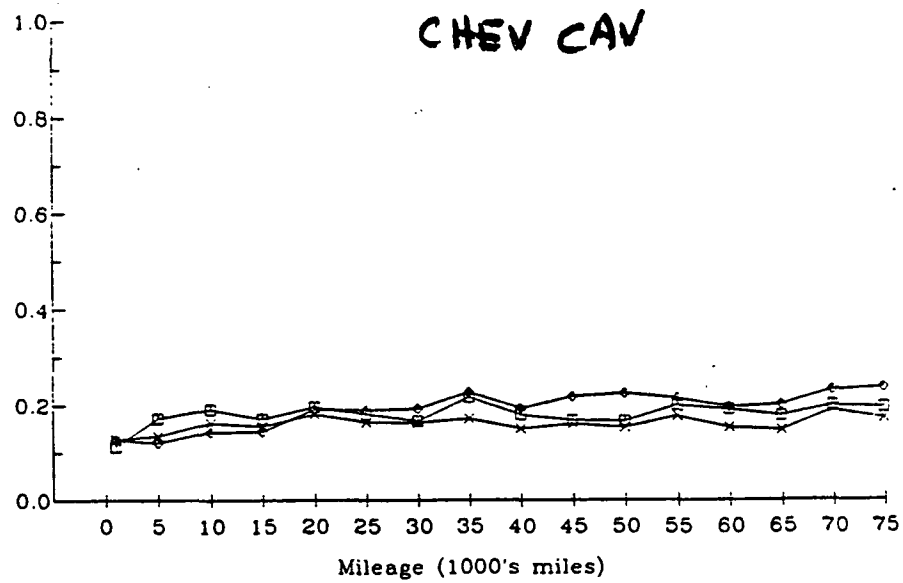
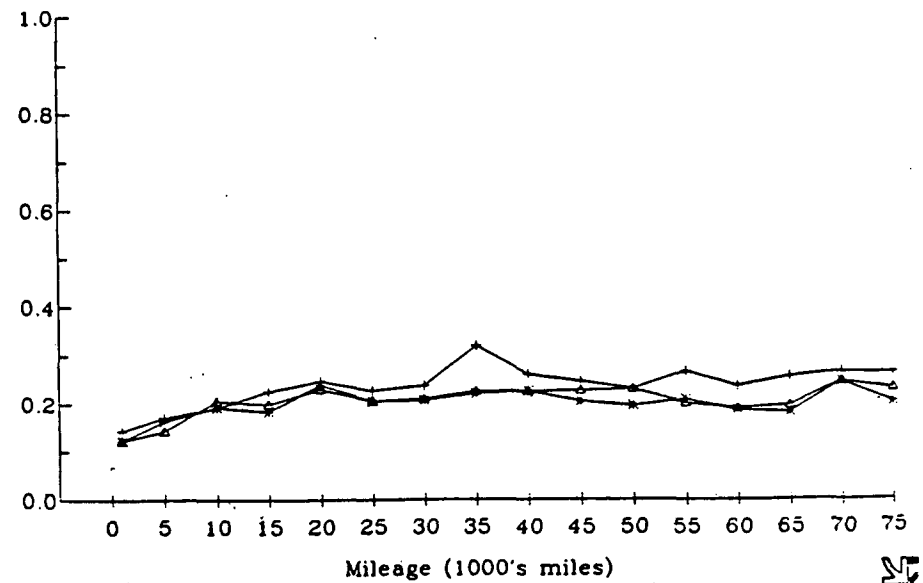
Average Tailpipe Hydrocarbon Emissions for Model Group C

EEE cars

CHEV CAV



HiTEC 3000 cars



Car # 1 Car # 4
Car # 2 Car # 5
Car # 3 Car # 6

ETHYL4S2 3/30/90 Systems Applications, Inc.

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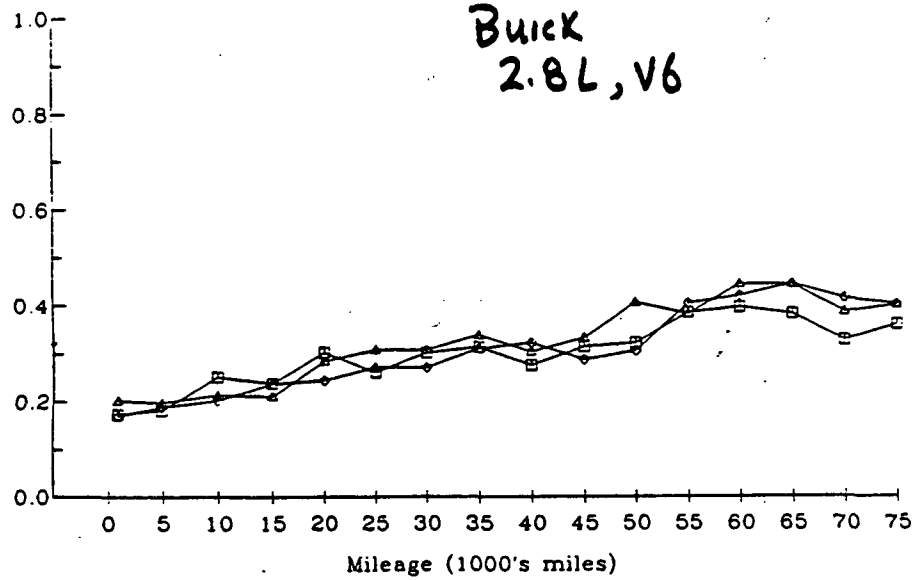
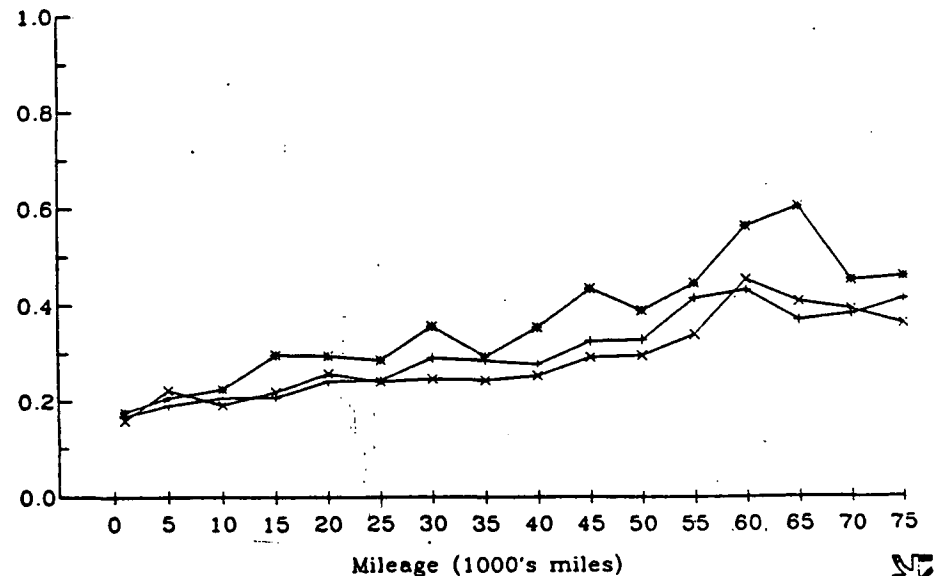
Average Tailpipe Hydrocarbon Emissions for Model Group H

EEE cars

Buick 2.8L, V6



HiTEC 3000 cars



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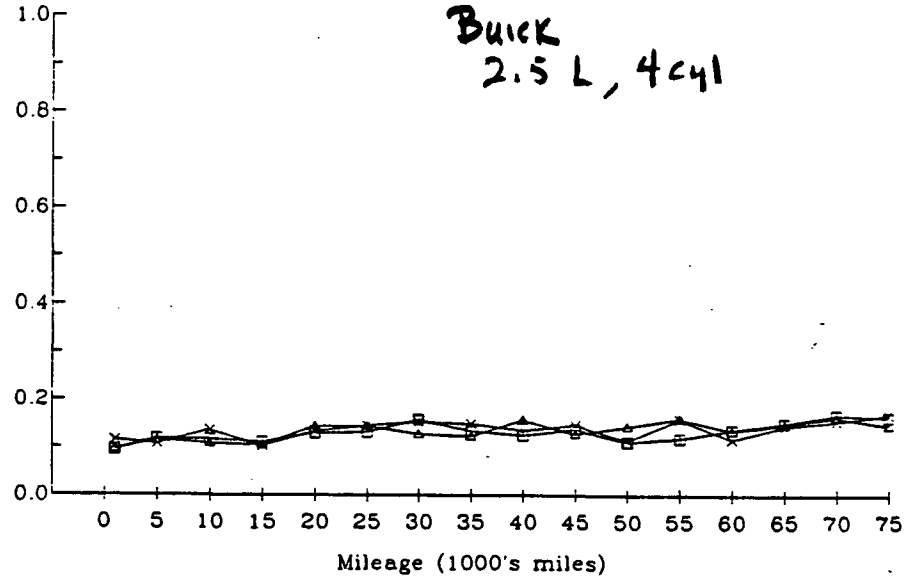
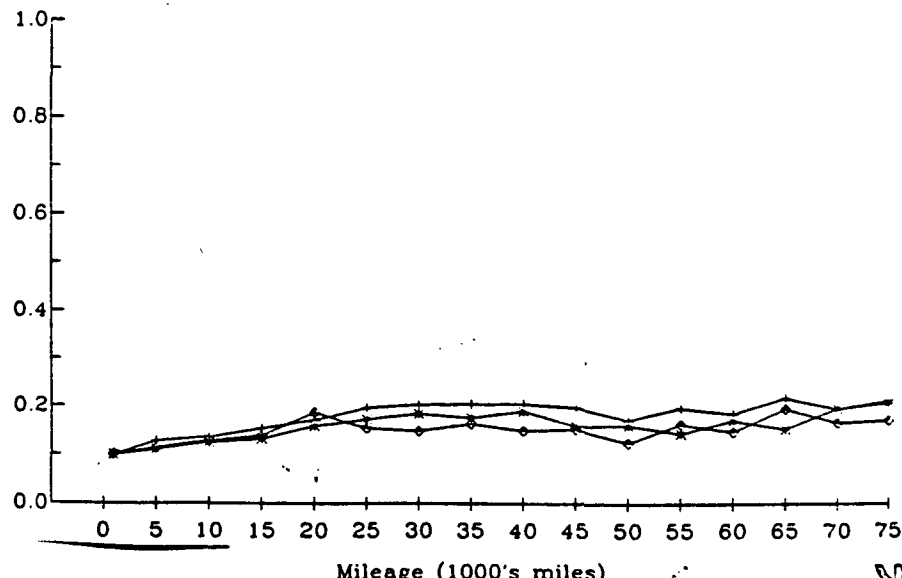
Average Tailpipe Hydrocarbon Emissions for Model Group G

EEE cars

Buick 2.5 L, 4cyl



HiTEC 3000 cars



ETHYLAS2 3/30/90 Systems Applications, Inc.

B-30

Car # 1
Car # 2
Car # 3
Car # 4
Car # 5
Car # 6

Ethyl Fleet 75,000-mile Data Sets

Number and description of excluded tests

Data Set	No. tests	Description
ETHYL0S	1	D3A Accident
ETHYL1S	164	Zero-mile tests
ETHYL2S	136	Invalid tests
ETHYL3S	339	Unscheduled maint.
ETHYL4S	151	"Extra" tests